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Research Article

INVESTIGATION AND ASSESSMENT OF OCCUPATIONAL RISK ON THE METAL CUTTING MACHINE TOOL STAND

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ABSTRACT
The paper analyzes occupational risk at selected metal cutting machine tool stands (turning, milling, drilling and grinding stands) and presents a set of recommendations formulated to minimize hazards at the above mentioned stands. The assessment is based on the analysis that allowed for selecting the best method of occupational risk assessment, measurements, observations, interviews and conclusions drawn from the obtained results. Occupational risk assessment forms were devised, what allowed for selecting appropriate action to increase the safety of selected machinery operators. The guidelines were assessed in terms of their practical implementation and expected utilitarian results.

Keywords: occupational risk, metal cutting machine tools, acoustic hazards, vibrations, occupational risk assessment forms.

INTRODUCTION

Metal machining is the most common manufacturing method that the machine industry development is based on. The observed trends of increasing efficiency of metal machining entail increasing machinery operating speeds, which, in turn, increases the risk of accidents at such stands. The most common hazards include: all kinds of mechanical injuries, exposure to high levels of noise, body exposure to vibrations, risk of electric shock, high temperature of chips, chemical substances present in cutting tool lubricants and their toxic fumes. These hazards pose a certain risk for operators of machine tool stands. In order to be reduced, occupational risk should first be assessed, as only then the sources of main hazards can be identified and eliminated. Under point 7 of §2 of the general health and safety regulations and the norm PN-N-18002:2000, occupational risk is defined as: „the probability of undesired events connected with the performed work causing damage, particularly adverse health effects of employees, due to occupational hazards resulting from work environment or manner of work" [13].

Occupational risk is comprised of many factors; under §39 of the general health and safety regulations, they are divided into 8 categories: injuries, diseases, occupational diseases, employee health, harmful and dangerous factors, employee qualifications, state of safety and health at work, and many others [1–4].

The concept of occupational risk pertains to all economic activities. Apart from casualties, it also involves material losses. Yet, given that under labor law the human being is considered the most important, it was therefore decided that occupational risk should always concern human resources [5-24].

OBLIGATION OF OCCUPATIONAL RISK ASSESSMENT

Occupational risk assessment is one of the obligations of every employer, irrespective of type and level of harmful, dangerous and noxious factors in workplace. This obligation pertains to all work positions and is regulated by relevant laws [19].

Under article 226 of the Labor Code, every employer is obliged to assess and record occupational risk involved in work performed, to inform employees about occupational risk and safety measures protecting from hazards as well as to administer essential preventive measures reducing the risk.

Under §39 of the general health and safety regulations issued by the Minister of Labor and Social Policy, the employer is obliged to conduct and record occupational risk assessment. The employer is obliged to take records of the administered essential preventive measures [18].

The above requirements result from the European Union directives. Under article 6 of the framework directive 89/391/EWG, employers should prevent occupational risk by minimizing hazards to safety and health of their employees. The employer is required to follow the rules specified in the above mentioned directive which include: hazard prevention, assessing hazards that cannot be eliminated, eliminating sources of hazards, implementing new technological solutions, replacing dangerous operations with operations that pose less danger or no danger at all, proper training and instruction of the staff, proper preventive policy and its coherent development, giving priority to collective preventive measures over individual preventive measures [18].

According to the latest amendments to the Labor Code, that is, the revised version of article 235, effective from July 3, 2009, the employer is obliged to determine causes of occupational diseases as well as the character and extent of hazards causing these diseases. The definition of occupational disease was transferred to the Labor Code from the law on social security in respect of accidents at work and occupational diseases [6].

Under article 227 of the Labor Code, employers are obliged to counteract occupational diseases. To this aim, they should administer measures that prevent occupational diseases and other diseases involved in the performed work. These measures include: keeping in proper operational condition, both devices that limit or eliminate health-harmful factors in work environment and devices that are used to measure these factors, conducting at their own expense the examination and measurement of factors harmful to health, to record and store the examination results, as well as to make them accessible to employees [19].

Even though legal regulations do not unequivocally name the person responsible for conducting occupational risk assessment, it should be conducted by competent persons (a company employee, external consultant, etc.). The norm PN-N-18002:2000 recommends that the following data be used in assessing occupational risk: information about stand localization and tasks performed there, information about employees operating the stand, particularly about those to whom special criteria are applied such as pregnant women, young and inexperienced employees or the disabled. Occupational risk assessment involves conducting relevant analyses (technical analysis of machinery and devices used, instructions for stand operators, etc.), measurements of harmful or dangerous factors that occur at the stand (allowable concentration values and other values determined for a given stand according to the legal regulations and norms [13]), visual inspections and staff interviews (gathering information about work measures used, preventive measures, materials and performed operations as well as the manner and time of performing these operations by the employees). The analysis of immeasurable values should be performed, most of all, by close observation of work environment, manner of performing work at a given stand and outside it, as well as by conducting invaluable staff interviews [13].

Those who conduct occupational risk assessment should possess appropriate knowledge and information about the following: identified hazards, risk types and how they are posed; materials, machines and technologies used at work; wok procedures and organization; staff exposure to materials used; type, probability, frequency and duration of hazard exposure; effects of exposure to certain harmful factors; norms and legal requirements concerning risk types at a given workplace. Such persons need to know and understand the rules and the idea of occupational risk assessment; additionally, it is recommended that they should be capable of inventing corrective or/and safety measures and of assessing their effectiveness [6].

When conducting risk assessment, relevant norms and legal regulations concerning the stand being analyzed should be observed. What should also be taken into account is the data about hazards and their sources detected on a given stand earlier, effects, accidents, occupational diseases, failures that have taken place, etc. [13].

Risk level assessment connected with the work performed at a given stand should be conduced whenever new stands are introduced or the existing stands are to be changed. Occupational risk assessment is also necessary when technological process or work organization is to be modified. Also, such analysis should be conducted for preventive reasons in order to avoid hazards resulting form the worsening of machinery operational condition, staff rotation or other factors that went undetected in previous inspections [13].

PURPOSES OF OCCUPATIONAL RISK ASSESSMENT

The main purposes of conducting occupational risk assessment include:

- identifying hazards which occur on the tested stands,
- determining the probability of their occurrence,
- determining the effect of the identified hazards on employees and work environment,
- selecting the optimal stand equipment, materials, safety measures and methods of work organization, and, having identified the hazards, even selecting adequate employees to operate such stands, [16]
- establishing priorities concerning the reduction or total elimination of hazards [16],
- constant improvement of safety and health at work [16],
- demonstrating to both employees and control bodies (e.g. National Labor Inspection agents) that the risk is known and appropriate measures to eliminate it have been taken.

Occupational risk assessment begins with determining machine function, together with the production profile of this machine, its efficiency, materials used, spatial limits and application type, planned cycle life, functions and modes of operation, predicted machine malfunctions and probable failures, employees responsible for operating the machine, and involuntary machine operation or its reasonably predictable misuse. Examples of involuntary machine operation or its reasonably predictable misuse include: machine control loss, reflex action in the case of machine malfunction, failure or damage, improper behavior resulting from concentration loss or inattention, operating the machine in an irresponsible manner, haste, etc. When assessing occupational risk, hazards taken into consideration should include both the ones that may occur at the stage of determining machine functions (design, production) and, most importantly, those that may occur at all stages of machine life cycle (Table 1).

Having identified the hazards, risk assessment for every hazardous situation being considered (for all hazards) should be conducted. The risk depends on such factors as the level of damage caused by a given hazard (*L* – low, *M* – medium, *H* – high) and the probability of damage occurrence (Figure 1), resulting from exposing an employee or employees to the hazard, a hazardous event and technical and human capabilities of preventing or limiting the damage.

Occupational risk assessment can be conducted using various tools, such as risk tables, risk charts, numerical methods, and the like. When assessing occupational risk based on risk calculation results, it needs to be established if safety measures are necessary to be taken and when the required risk reduction is to be obtained. Risk assessment results need to be recorded. The risk assessment records should include the procedure applied and results obtained, as well as such data as machine tech-

Table 1. Hazard identification when assessing occupational risk

Hazards which have to be considered by producers …	….and in all stages of machine life cycle
• mechanical hazards	• transport, assembly and mounting
• electrical hazards	• start-up
• thermal hazards	• repairs
• hazards caused by noise	• verification of units and elements
• hazards caused by vibrations	• renovation
• hazards caused by radiation	• regeneration of units and elements
• hazards caused by materials and substances	• normal operation and failure elimination
• hazards caused by lack of ergonomic solutions	• maintenance and cleaning
• hazards resulting from slipping, tripping or falling	• disassembly
• hazards connected with machine working environment	• utilisation
• hazards resulting from the above hazards combined	

Fig. 1. Risk calculation and assessment

nical details, assumptions made, all identified hazards and dangerous situations, events, data used and their sources, description of safety measures applied, description of risk-reduction aimed that are feasible using the safety measures applied, residual risk connected with a given machine, documents prepared in the course of risk assessment.

METHODS OF OCCUPATIONAL RISK ASSESSMENT

There are numerous methods of occupational risk assessment. Given the accuracy of risk assessment and type of data, the methods can be divided into two categories: qualitative and quantative [2, 16–22].

The qualitative methods are employed if there is no access to statistical databases providing such information as number and type of accidents, dangerous events, occupational diseases, time of exposure to harmful factors, and the like [2]. If there is no access to such information, one of the methods of event occurrence should be employed. The risk (R) can be expressed as a function (2).

$$R = f(P, S) \quad (1)$$

where: S – the outcomes caused by the event,
P – the probability of outcome occurrence,
R – the assessed occupational risk.

This value can be determined in a descriptive manner (linguistically, qualitatively) or by means of numbers (quantitatively). The outcome probability employed in the qualitative methods is not mathematically defined, but it is rather a measurement which states that outcomes of different events are assessed at different levels. The risk is expressed as a combination of event frequency (probability) and consequences of their outcomes. The qualitative methods include: Preliminary Hazard Analysis (PHA), Risk Score, the method of five steps to risk assessment, risk graph and risk matrices according to the norm PN-N-18002 [2].

EXPERIMENTAL TESTS AND THEIR RESULTS

Operating metal working machine stands always poses numerous hazards, the applied safety measures notwithstanding. A vast number of such hazards occur over time and they are impossible to avoid. This results, among others, from changes in work environment, machinery wear, failures, and ignoring the industrial safety regulations on part of employees [2]. The Polish Norm PN-80/Z-08052 – Work protection. Dangerous and harmful factors in the work process describes hazards that should be taken into consideration when assessing occupational risk, yet not all of the hazards listed therein pertain to machining stands. Out of these hazards, 7 most important ones have been selected for the sake of the present paper. They include: exposure to high noise level, vibrations (measurable factors), risk of falling down on the same level, injures caused by movable machine parts, the risk of being thumped or cut by protruding machine elements, the risk of burns and electric shock [8]. The fundamental safety measures against the above hazards involve proper machinery arrangement and using shields protecting against injuries caused by chips and cooling agent splashing. Each stand should be equipped with a valid industrial safety manual. As for the measurable factors, periodic inspections of their maximum allowable concentration (MAC) and maximum allowable intensity (MAI) should be conducted. The pathway distance between the machines should be of at least 0.75 m, and there should be 2 m^2 of free floor space per employee. The room should be provided with proper lighting and ventilation [2].

The study was undertaken to assess occupational risk involved in operating metal cutting machine tools such as: turning lathes – S-32, Cu-401 and C-11; milling machines – FWF-32, FYA -32 and FNB-26, drilling machines: WS-15 and WKA-25; as well as grinding machines: SPC-20 and SWA-10. The study involved measuring noise and vibrations generated by the metal cutting machine tools as well as visual inspection necessary to assess immeasurable hazards. The noise measurement was done in the manner specified by the norm PN-N-01307:1994. Requirements for conducting measurements-namely, the microphone was at a height of 1.2 m over the floor and its distance from the machine was the same as the distance of the operator from the machine. The noise measurements were done using a Sonopan P-01 meter. Another thing used was a correction filter type A, which is applied to measure maximum intensity level of sound A. Such filter best reflects the noise and frequencies the human ear is exposed to. The maximum allowable sound level is 85 dB, standardized by legal regulations and norms [11].

In order to measure vibration level, a vibration meter, SEQUOIA Triaxal Acceleration Computer, was used. It was connected to a signal converter and computer monitoring the vibrations. The sensor was mounted on the machine housings so as to best examine the vibrations that an operator is exposed to. The vibration level was examined in the Y axis because vibrations in this direction were the highest and affected the machine operators most. The obtained results were copied to a spreadsheet and – based on the data— relevant charts were made as well as the standard deviation σ and the maximum allowable value of vibration acceleration in the direction of the Y axis (1) were determined [16].

$$a_{hv,30min,dop} = \max\{\sqrt{a_{y1}^2}, \sqrt{a_{y2}^2}, \sqrt{a_{y3}^2}, \ldots, \sqrt{a_{yn}^2}\} \quad (1)$$

It was assumed that vibrations affect the human body via the upper limbs (local vibrations) and the time of their action is shorter than 30 minutes. In accordance with such data, the acceptable value of short-term exposure to vibrations was taken as $a_{hv,30min,dop} = 11.2\ m/s^2$.

COMPARISON OF THE TESTED MACHINE GROUPS

Table 2 and Figure 2 offer a comparison of results of measured noise level emitted on the tested metal cutting machine tool stands. Such comparison allowed for distinguishing two groups of machines: one including machines which pose lowest hazard for their operators' health and one which comprises machines posing the highest hazard for their operators' health.

Table 3 and Figure 3 compare the obtained standard deviation σ and peak value a_{hvmax} for vibration acceleration measurements in the direction of the *Y* axis for the examined metal cutting machine tool stands. The acceptable acceleration value was taken as $a_{hv,30min,dop} = 11.2\ m/s^2$.

In occupational risk assessment, the most significant parameter caused by local vibrations, that is, the ones affecting human body via the upper limbs, is the vibration acceleration peak value a_{hvmax}; the acceptable value for this vibration type is 12.8 m/s^2. From Table 3 it can be inferred that as many as five out of the examined machine tool stands do not satisfy the above mentioned condition. Out of all the machines, it is the milling machine FYA-32 that poses a higher hazard in this respect, while the drilling machine WS-15 is the safest.

Table 2. Comparison of minimum, maximum and mean noise intensity levels on all the tested stands EA

Noise intensity level [db]	Turning lathes		Milling machines		Grinding machines		Drilling machines	
	idle run	operation test	idle run	operation test	idle run	operation test	idle run	operation test
Mean	80.3	87.9	85.33	86.11	91.00	96.00	88.25	85.50
Min	68	82	82	83	90	96	87	82
Max	87	93	92	88	92	96	89	88

Table 3. Comparison of vibration parameters of the tested machine groups, $a_{hv,30min,dop} = 11.2\ m/s^2$

Group	Symbol	Minimum standard deviation σ [m/s²]	Maximum standard deviation σ [m/s²]	Mean standard deviation σ_{sr} [m/s²]	Peak value a_{hvmax} [m/s²]
Turning lathes	S-32	1.27	7.79	5.29	28.1
	C-11	0.25	3.47	1.64	9.86
	CU401	0.51	7.28	3.23	22.3
Milling machines	FYA-32	0.25	13.3	3.53	40.2
	FWF-32	0.16	2.29	0.79	10.1
	FNB-26	1.44	9.91	4.98	19.36
Drilling machines	WKA-25	0.17	4.06	1.27	10.1
	WS-15	0.17	0.18	0.18	4.3
Grinding machines	SWA-10	0.08	1.44	0.76	5.21
	SPC-20	0.25	0.59	0.42	14.06

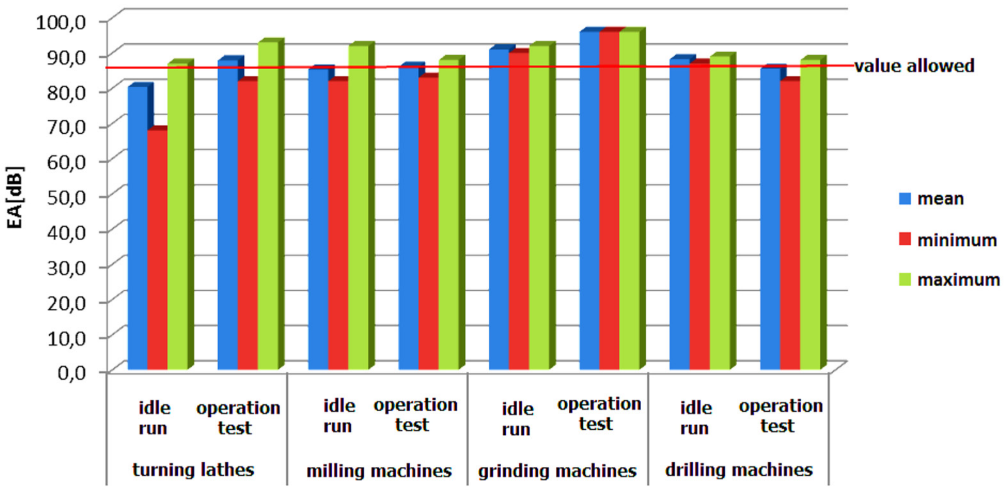

Fig. 2. Comparison of noise levels emitted by machines on tested metal cutting machine tool stands, EA_{dop} = 85dB – marked in the chart by a horizontal line

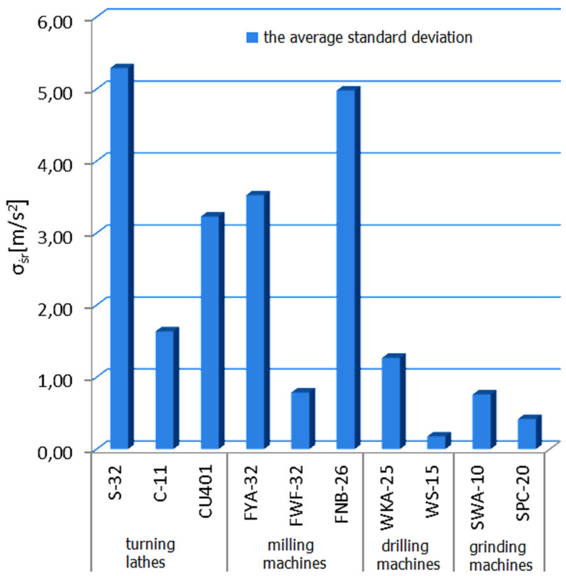

Fig. 3. Comparison of mean standard deviations of vibration acceleration in the direction of the *Y* axis of the tested stands

From a technological point of view, the standard deviation σ is a more important parameter describing vibrations. The bar chart in Figure 3 illustrates a comparison of mean standard deviations, which allows for selecting each time the least technically efficient machines, that is, the machines which have the highest mean standard deviation $\sigma_{śr}$.

OCCUPATIONAL RISK ASSESSMENT FORM FOR THE TESTED STANDS

In order to devise occupational risk assessment forms for the examined stands, it was first necessary to measure noise level and vibration acceleration, conduct inspection and carry out interviews with employees.

The method selected to conduct occupational risk assessment complied with the norm PN-N-18002/2000 due to its transparency and the possibility of assessing both measurable and immeasurable values. This method is best known and most often described in the literature, and, as a result, most often employed by all kinds of companies, including those dealing with metal machining. The forms contain modifications and recommended preventive measures and means of reducing the risk involved in operating the examined stands. In addition to that, occupational risk after the application of the suggested recommendations was also assessed. The devised occupational risk forms are shown as tables. Table 4 is an example of the risk assessment form devised for a turning lathe S-32. Similar forms were made for other tested machines.

CONCLUSIONS

The analysis of the available works and the conducted research allowed for assessing occupational risk on the selected metal cutting machine tool stands. Based on the conducted experimental tests, the following have been found:

- the fastest, most transparent and, at the same time, simplest method of occupational risk assessment is the method which complies with the norm PN-N-18002:2000.
- in the examined machine groups, the safest machine tools include milling and drilling stands,

Table 4. Occupational risk assessment form for a metal cutting machine tool stand (occupational risk assessment form devised for a turning lathe S-32, risk assessment levels: *L* – low, *M* – medium, *H* – high)

Hazards	Source of hazard	Potential hazard effects	Before assessment			Recommendations	After implementing recommendations		
			probabilty (P)	risk (T)	level (L)		probabilty (P)	risk (T)	level (L)
Noise	Machines	Hearing damage, neuroses	M	L	L	Keep the machine in proper operating condition, provide employees with hearing protectors.	L	L	L
Vibrations	Machines	Nervous system damage, cardiovascular system damage, vibration white finger	M	M	M	Keep the machine in proper operating condition, provide vibration damping devices.	M	L	L
Falling on the same level	Slippery, uneven ground	Contusions, fractures, internal injuries	M	L	M	Provide proper footwear. Keep the workplace in order; wipe up any spilt liquids immediately.	M	L	L
Injuries caused by movable machine parts	Cutting tools, power units	Personal injury, death	H	H	H	Use shields and proper tools, wear protective clothing (without any loose elements) when operating machinery.	M	M	M
Thumps, cuts	Improperly mounted object, chips	Personal injury, death	H	H	H	Mount the workpiece properly. Do not remove chips by hand, use shields and safety goggles.	M	M	M
Burns	Cooling liquid, chips	Burn wounds	M	H	H	Equip the stand with shields against hot chips.	L	L	L
Electric shock	Electrical breakdowns	Death	H	M	H	Perform periodic inspections of electrical installations	M	L	L

- the operation of turning lathes and grinding machines involves a higher risk of accidents and failures; the safest stands are: the drilling machine WKA-25, the milling machines FNB-26 and FWF-32; while the highest hazard is posed by the turning lathe S-32 and grinding machine SPC-20,
- the most common problem identified in occupational risk assessment is lack of protection against chips and fast rotating elements breaking off a machine or tool, which can cause grave injuries, cuts, or even death,
- emitted noise level should be taken into account – it is recommended that personal protectors be used as in the case of all the machines, except for the turning lathe S-32, the noise emission level is very close to the threshold limit value of 85dB or even exceeds it, especially in the case of grinding stands SPC 20 and SWA 10, where – at operation – this value is exceeded by 11dB.
- the group of machines in the worst technical condition includes: turning lathes – S32, whose mean standard deviation σ = 5,29 m/s^2, and peak value a_{hvmax} = 28,1 m/s^2, CU401, whose mean standard deviation σ = 3,23 m/s^2, and peak value a_{hvmax} = 22,3 m/s^2, and the milling machines – FYA-32 (mean standard deviation σ = 3,53 m/s^2; a_{hvmax} = 40,2 m/s^2) and FNB-26 (mean standard deviation σ = 4,98 m/s^2; a_{hvmax} = 19,36 m/s^2). In the case of these stands, the rigidity of the machine tool-chuck-workpiece-tool system should be enhanced and vibration damping tools should be applied as well,
- the group of machines in the best technical condition includes: the turning lathe C11, the milling machine FWF-32, the drilling machines WKA-25 and WS-15, as well as the grinding machines SWA-10 and SPC-20, where the acceptable peak value a_{hvmax} was not exceeded, and the values of standard deviation σ are very low (< 1.5 m/s^2),
- except for the drilling machines, all the other machines generate higher noise in operation tests than in idle running,
- there is no constant relationship between the rotational speed and emitted noise level EA because for some machines, such as the turning lathe CU401 or the milling machine FYA-32, an increase in the speed *n* leads to increased noise emission, while for other machines, for example the turning lathe C-11, the drilling machines WKA-25 and WS-15, it resulted in decreased emitted noise levels.
- carrying out the necessary maintenance repairs to improve the technical condition of

the examined machines will both ensure the safety to their operators and it will enhance the quality of machining conducted on these stands.

REFERENCES

1. Booth R.T. Risk Assessment Workbook. Aston University, Birmingham 1989.
2. Bryła R. Ocena ryzyka zawodowego na stanowisku obróbki skrawaniem metali. Stal - Metale i Nowe Technologie, 5-6, 2007.
3. Karczewski J.T., Rączkowski B. Ocena ryzyka zawodowego na stanowisku – tokarz, frezer. ODDK, Gdańsk 2000.
4. Kinney G.F., Wiruth A.D. Practical Risk Analyses for Safety Management. Naval Qweapons Centre, China Lake, 1976.
5. Lind N. Tolerable risk. International Conference on Safety, Risk and Reliability Trends in Engineering. IABSE, Malta 2001, Conference Report, ETH-Hönggerberg, Zürich 2001.
6. Norma EN 1050:1996. Safety of machinery – Principles for risk assessment.
7. Norma PN IEC 300-3-9:1999. Zarządzanie niezawodnością. Przewodnik zastosowań. Analiza ryzyka w systemach technicznych.
8. Norma PN-80/Z-08052. Ochrona pracy. Niebezpieczne i szkodliwe czynniki występujące w procesie pracy. Klasyfikacja.
9. Norma PN-91/N-01353. Dopuszczalne wartości przyspieszenia drgań oddziałujących na organizm człowieka przez kończyny górne i metody oceny narażenia.
10. Norma PN-EN ISO 14121-1:2008. Maszyny. Bezpieczeństwo. Zasady oceny ryzyka.
11. Norma PN-N-01307:1994. Hałas. Dopuszczalne wartości hałasu w środowisku pracy. Wymagania dotyczące wykonywania pomiarów.
12. Norma PN-N-18001:2004. System zarządzania bezpieczeństwem i higiena pracy. Wymagania.
13. Norma PN-N-18002:2000. System zarządzania bezpieczeństwem i higiena pracy. Ogólne wytyczne do oceny ryzyka zawodowego.
14. Norma PN-N-18002:2000. Systemy zarządzania bezpieczeństwem i higieną pracy. Ogólne wytyczne do oceny ryzyka zawodowego.
15. Projekt normy PN IEC 60300-3-9:2004. Zarządzanie niezawodnością. Przewodnik zastosowań. Analiza ryzyka w systemach technicznych
16. Romanowska-Słomka I., Słomka A. Zarządzanie Ryzykiem Zawodowym. Tarnobus Sp. z o.o. Tarnobrzeg 2001.
17. Romanowska-Słomka I. Ryzyko zawodowe – procedury, metody, zagrożenia, Wrocław 2006.
18. Smoliński D. Ocena ryzyka zawodowego na stanowisku pracy – poradnik, Wrocław 2001.
19. Stec D. Zasady BHP w praktyce, Kraków 2009.
20. Szczelina K. Ogólne wytyczne do analizy ryzyka zawodowego, Kraków 2009.
21. Tokarz W. Zarządzanie bezpieczeństwem pracy. Ocena ryzyka zawodowego. Zał. 4F. Wyd. FORUM, Poznań 2009.
22. Werner K. Ocena ryzyka zawodowego na stanowisku tokarza. Przyjaciel Przy Pracy, 6, 2009: 22-23.
23. www.gdansk.oip.pl/64.html (15.04.2013).
24. www.poznan.oip.pl/cutenews//data/doc/ocena_ryzyka.pdf (14.04.2013).